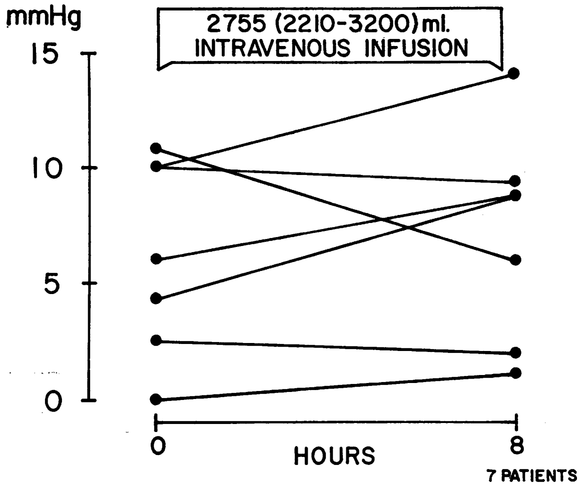

Chart 6.—Changes of central venous pressure after infusion of 2,210 to 3,200 ml of fluid over an eight-hour period in seven patients with circulatory shock.

ciency were successfully treated with fluids in large amounts, averaging 2,700 ml in an eight-hour period without other therapy. Their response to this treatment was a consistent increase in mean blood pressure (72 to 82 mm of mercury), cardiac index (2.6 to 2.9 L/min/M^2) and plasma volume (54 to 64 ml per kilogram of body weight). Changes in venous pressure are shown in Chart 6. The inconsistency in effects on central venous pressure emphasizes that venous pressure is not a measure of intravascular volume. However, it is a reliable indicator of the capacity of the heart to accept additional fluid. We recommend that this technique be routinely used for guiding fluid repletion in patients with clinical shock.

Cerebral Blood Flow in Hemorrhagic Shock

LOUIS L. SMITH, M.D.*

Hemorrhage summons compensatory mechanisms that assure maintenance of blood flow to vital organs, and especially to the brain. The effect of graded hemorrhage on total cerebral blood flow was investigated. In an experiment with dogs, the blood volume was measured and then the animals were bled at intervals of six hours. Eight per cent of the initial blood volume was removed each time. The blood flow through the carotid and vertebral arteries was measured by an electromagnetic flowmeter and related to arterial and central venous pressures, cardiac output and femoral arterial flow as observed before and during hemorrhagic shock. Twenty dogs were studied. In dogs, approximately 70 per cent of total cerebral flow is supplied by vertebral arteries. Vertebral blood flow was maintained at a significantly higher level than femoral blood flow. The larger the hemorrhage, the greater the disparity between vertebral and femoral arterial flow values.

Cerebral blood flow is selectively maintained at the expense of nonvital circulation to muscle and skin. Greater attention should be paid to cerebral function than to blood pressure per se, since the blood pressure is a poor index of cerebral blood flow during hemorrhagic shock.

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Newer Methods for Measuring Peripheral Flow in Man

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Because shock, or peripheral vascular collapse, is probably associated with a prolonged inadequacy of peripheral blood flow, it follows that a survey of the perfusion of each of the body tissues during shock would provide important data. Sur-

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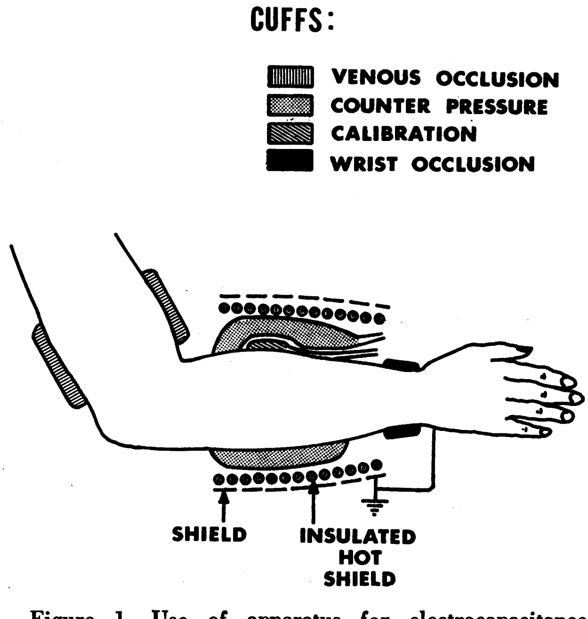

Figure 1.—Use of apparatus for electrocapacitance plethysmography.

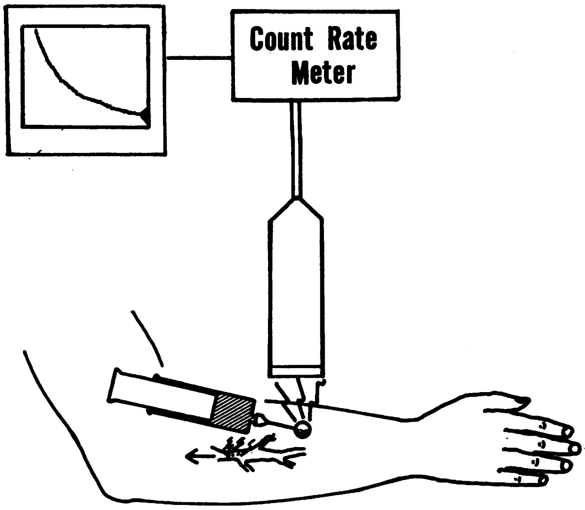

Figure 2.—Tissue clearance method for measurement of peripheral blood flow.

veys of this kind in animal preparations have already been undertaken, but only a few corresponding measurements of circulation in the human in shock have been reported. In general, only those methods should be considered that measure a relatively specific blood flow or perfusion rate and are not traumatic for the already debilitated patient.

Venous occlusion plethysmography is probably the least traumatic method available for measuring blood flow. The recently developed electrocapacitance plethysmograph (Figure 1) provides the additional advantage of leaving the part under study in its normal state: skin temperature, evaporation of sweat from the part and counter pressure on the tissue are unchanged. In addition, the practical advantages of simplicity and ease of handling make this technique the best approach of measurement of blood flow in the extremities.

Blood flow through skin and muscle can easily be separated by an extension of this method. The rate of volume increases after venous occlusion is diminished by pressure applied over the local area. With 25 to 35 mm of mercury in a cuff between the skin and the electrocapacitance screens, blood flow decreases to a level that represents perfusion of deep tissue only. This method has not yet been applied to patients in shock.

The so-called tissue clearance method would also be applied to the evaluation of peripheral circulation in shock (Figure 2). The rate of removal of a small ionic solute from a local injection site in tissue fluid mirrors the rate at which similar molecules are removed from tissues, and provides an estimate of the efficiency of local blood flow. The method involves no trauma, can be directed at a specific tissue, and promises information concerning the physiologically important nutritional flow through the periphery.

Renal Morphology in Patients With Shock

RICHARD E. HOROWITZ, M.D.*

In reviewing the postmortem findings in patients who died on the Shock Ward in 1963, it was found that the most common kidney alteration was the classical "shock kidney," grossly characterized by a pale cortex and a dark red medulla. Microscopically, such kidneys had relatively anemic cortices and pronounced congestion of the vasa recta. Such changes occurred in virtually all patients in shock.

Acute tubular necrosis, also ineptly called lower nephron nephrosis, is thought to be an invariable component of shock. The criteria used for this diagnosis are: (1) patchy necrosis of convoluted tubules; (2) fragmentation of tubular basement membranes; (3) focal acute inflammation; and (4) red cell or heme casts (Figure 3). These changes were observed in only seven of 38 patients with shock and were severe in only three. No cases of renal cortical necrosis were observed, although fibrin thrombi in the glomerular capillaries, the early

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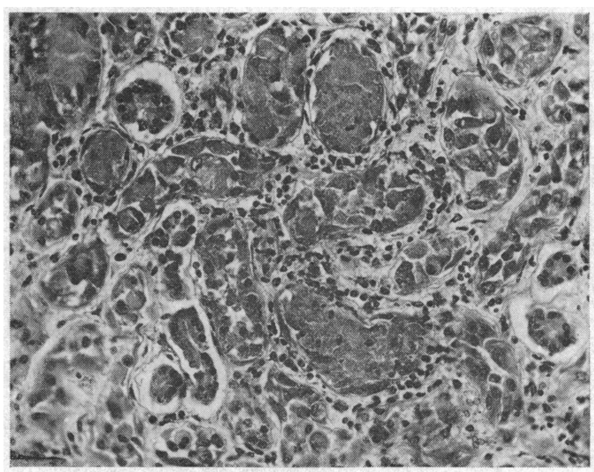

Figure 3.—Acute necrosis of renal tubules. Note necrotic tubular cells, acute inflammation and fragmentation of tubular basement membranes. Hematoxylin and eosin stain, ×250.